APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

AFPTEF REPORT NO. 06-R-02
AFPTEF PROJECT NO. 05-P-107

MATTHEW P. BOZZUTO
Project Engineer
matthew.bozzuto@wpafb.af.mil
DSN 787-7166
Comm (937) 257-7166

SUSAN J. EVANS
Qualification Test Engineer
susan.evans@wpafb.af.mil
DSN 787-7445
Comm (937) 257-7445

Development of the Combat Talon I – APQ-122 – Terrain Following Radar (TFR) Antenna Container, CNU-682/E, NSN 8145-01-535-3979

AFMC LSO/LOP
AIR FORCE PACKAGING TECHNOLOGY & ENGINEERING FACILITY
WRIGHT PATTERSON AFB, OH 45433-5540

March 2006

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **MAR 2006**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**
4. TITLE AND SUBTITLE **Development of the Combat Talon 1-APQ-122-Terrain Following Radar (TFR) Antenna Container**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **AFMC LSO/LOP Air Force Packaging Technology & Engineering Facility Wright Patterson AFB, OH 45433-5540**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release, distribution unlimited**		
13. SUPPLEMENTARY NOTES **The original document contains color images.**		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**44**	

AFPTEF PROJECT NO. 05-P-107
TITLE: Development of the Combat Talon I – TFR Antenna Container

ABSTRACT

The Air Force Packaging Technology Engineering Facility (AFPTEF) was tasked with the design of a new shipping and storage container for the Combat Talon I – TFR Antenna in May of 2005. The new container is designed to replace the fiberglass container that was previously used.

The main problems with the fiberglass design were corrosion due to inadequate environmental control and protection, isolation system breakdown, and that there was no provision for effective warehouse stacking capability. AFPTEF solved these problems. The CNU-682/E, designed to SAE ARP1967A, is an aluminum, long-life, controlled breathing, reusable shipping and storage container. The new container, CNU-682/E, protects the TFR Antenna mechanically and environmentally. In addition, the new container makes the item much easier to maneuver during worldwide shipment and storage. The container passed all qualification tests per ASTM D4169.

The CNU-682/E container not only meets user requirements but also provides an economic saving for the Air Force. The savings will be thousands of dollars over the twenty-year life span of the container.

Total man-hours: 440

PROJECT ENGINEER:

Matthew P. Bozzuto
Mechanical Engineer
AFPTEF

TEST ENGINEER:

Susan J. Evans
Mechanical Engineer
AFPTEF

APPROVED BY:

Robbin Miller
Chief, Air Force
Packaging Technology &
Engineering Facility

PUBLICATION DATE:

4/3/06

TABLE OF CONTENTS

APPENDIX

INTRODUCTION

BACKGROUND – The Combat Talon I – APQ-122 – Terrain Following Radar (TFR) Antenna was previously stored in a fiberglass container. The container did not have environmental controls and was not sealed by the nature of its construction. These two factors allowed the container to "breathe" with continuously changing environmental conditions. There was no means to control breathing or remove the excess moisture that resulted, which caused a corrosion problem on the antenna. The cradle system seemed adequate based on the lack of reported shipping damage. However, in many cases the foam based cradle system broke down and was totally ineffective for mitigating shock to the antenna. Based on the success of the Combat Talon I – APQ-122 – Ground Mapping Radar (GMAP) Antenna Container that AFPTEF designed and manufactured, representatives from Robins AFB decided that they wanted the same level of protection for the TFR Antenna. Logistics and Sustainment personnel at Robins AFB contacted AFPTEF to request the design of a reusable container that would eliminate the shipping and storage risks.

REQUIREMENTS – AFPTEF and Robins AFB personnel agreed upon a list of requirements during initial design discussions. Many of these requirements were not met by the fiberglass container. The requirements are as follows:

- Sealed/controlled-breathing container that protects against varied environmental conditions and weather during either inside or outside shipping and storage
- No loose packing material
- Antenna Shock/Vibration limited to 20 Gs
- Reusable and designed for long life (20 years)
- Low maintenance
- Field repairable hardware
- Forklift capabilities

DEVELOPMENT

DESIGN – The TFR Antenna Shipping and Storage Container (CNU-682/E) design meets all the users' requirements. The CNU-682/E (see Appendix 2, Figure 1) is a sealed, welded aluminum, controlled breathing, reusable container. The container is engineered for the physical and environmental protection of the antenna during worldwide transportation and storage. The container consists of a base and completely removable cover equipped with the special features listed below. The base is a one piece skid/double walled base extrusion with forklift openings, humidity indicator, pressure equalizing valve (1.5 psi pressure/ 1.5 psi vacuum) and desiccant port for easy replacement of desiccant (controls dehumidification). A silicone rubber gasket and quick release cam-over-center latches create a water/air-tight seal at the base-cover interface. Container external dimensions are 41.5 inches length, 28.8 inches width, and 28.7 inches height. Container empty weight is 183 pounds, and 220 pounds with the antenna in place.

An aluminum cradle system is mounted on helical steel isolators (see Appendix 2, Figure 2), which in turn are mounted to the interior container sides. The isolators limit the transmission of shock to the antenna to 20 Gs. The antenna is attached to the cradle system with eight bolts that are captive on the antenna (see Appendix 2, Figure 3).

In addition to the antenna, there is also a section of the container that accommodates the waveguide. This compartment is located on the aft end of the container and is made of a built up polyethylene foam cushion and detachable lid. The waveguide compartment lid is held in place by three linch pins (see Appendix 2, Figure 5) that pass through three posts that are welded into the container base. Appendix 2, Figure 4 shows the cushion and lid in the open position with the lid removed.

TFR ANTENNA CONTAINER FEATURES	
Pressure Equalizing Valve	1
Humidity Indicator	1
Desiccant Report	1
Document Receptacle	None
Forkliftable	Yes
Cover Latches	10
Cover Lift Handles	2
Cover Lift Rings	None
Cover Tether Rings	None
Base Lift Handles	None
Base Tie-down Rings	4
Stacking Capability	Yes

PROTOTYPE – AFPTEF fabricated one CNU-682/E prototype container (see Appendix 2, Figure 6 and 7) in house for testing. The prototype container was fabricated in accordance with (IAW) all requirements and tolerances of the container drawing package, and had a tare weight of 183 lb. The drawing package used for prototype fabrication has been released for the manufacture of production quantities of the container. Each face of the container was uniquely identified for testing identification as shown below.

DESIGNATED SIDE	CONTAINER FEATURE
Top	Cover Top
Aft	Desiccant Port
Right	Right Side from Aft
Left	Left Side from Aft
Forward	Opposite Aft
Bottom	Base Bottom

QUALIFICATION TESTING

TEST LOAD – The test load was an unserviceable TFR antenna (see Appendix 2, Figure 6). A triaxial accelerometer, used to record actual accelerations sustained by the antenna, was mounted on the test load as close to the center of mass as possible. The test load weight was 36 lb.

TEST PLAN – The test plan primary references were ASTM D 4169 and SAE ARP 1967 (see Appendix 1). The test methods specified in this test plan constituted the procedure for performing the tests on the antenna container. The performance criteria for evaluation of container acceptability were specified at 20 Gs maximum and an initial and final leak rate of 0.05 psi per hour at 1.5 psi. These tests are commonly applied to special shipping containers providing rough handling protection to sensitive items. The tests were performed in September, 2005 at AFPTEF, Building 70, Area C, Wright-Patterson AFB.

ITEM INSTRUMENTATION – The test load was instrumented with a piezoelectric triaxial accelerometer mounted as close as possible to the antenna's center of mass. Accelerometer positive axis orientations were as follows:

X Axis - Directed through container Forward and Aft (Longitudinal motion).
Y Axis - Directed through container Left and Right sides (Transverse motion).
Z Axis - Directed through container Top and Bottom sides (Vertical motion).

See Appendix 4 for detailed accelerometer and other instrumentation information.

TEST SEQUENCES – Note: All test sequences were performed at ambient temperature and humidity, unless otherwise noted in the test procedure.

TEST SEQUENCE 1 – Leak Test

Procedure – The left desiccant port cover was removed and replaced with a port cover modified for attachment of the digital manometer and vacuum/pressure pump lines. The container was closed and sealed. The leak test was conducted at ambient temperature and pressure. The pneumatic pressure leak technique was used to pressurize the container to a minimum test pressure of 1.5 psi. Maximum allowable leak rate is 0.05 psi per hour. (see Appendix 2, Figure 7).

Results – The container passed the leak test with a leak rate less than the maximum allowed rate of 0.05 psi per hour.

TEST SEQUENCE 2 – Vibration Test, Resonance Dwell

Procedure – The container was rigidly attached to the vibration platform. A sinusoidal vibration excitation was applied in the vertical direction and cyclically swept for 7.5 minutes at 2 minutes per octave to locate the resonant frequency. Input vibration from 5 to 12.5 Hz was at 0.125-inch double amplitude. All signals were electronically filtered using a two-pole Butterworth filter with a 600 Hz cutoff frequency. The peak transmissibility values during the up and down

frequency sweeps were noted for use in determining the frequency search range for the resonance dwell test.

The vibration controller swept up the frequency range until the resonant frequency was reached. This frequency was manually tracked for a 30 minute resonance dwell test. The test was conducted at ambient temperature. (see Appendix 2, Figure 8)

Results – The resonant frequencies of the packaged item ranged from an initial 10.75 Hz to 10.92 Hz. The transmissibility throughout the test was 1.5. At the end of the test period, there was no damage to the container or antenna. The container met the test requirements. (see Appendix 3, Table 2 and Waveforms.)

TEST SEQUENCE 3 – Loose Load Vibration, Repetitive Shock

Procedure – A sheet of 3/4-inch plywood was bolted to the top of the vibration table, and the container was placed on the plywood. Restraints were used to prevent the container from sliding off the table. The container was allowed approximately 1/2-inch unrestricted movement in the horizontal direction from the centered position on the table (see Appendix 2, Figure 9).

The table frequency was increased from 3.5 Hertz (Hz) until the container left the table surface (approximately 4.23 Hz). At one-inch double amplitude, a 1/16-inch-thick flat metal feeler could be slid freely between the table top and the container under all points of the container. Repetitive shock testing was conducted for 2 hours at ambient temperature.

Results – The loaded container was vibrated at 4.23 Hz for 2 hours. The maximum peak amplitude during this time (vertical axis) was approximately 3 Gs. At the end of testing there was no visible damage to the either the container or the item. The container met the test requirements. (see Appendix 3, Waveforms.)

TEST SEQUENCE 4 – Rotational Drops

Procedure – An Assurance Level I drop height of 762 mm (30 in.) was used to perform four corner and four edge drops onto a one-inch thick steel plate inside the conditioning chamber, and the impact levels were recorded. The maximum allowed impact level for the antenna was 20 Gs. (see Appendix 2, Figure 10.)

Results – All recorded impacts were less than the maximum allowed 20 Gs. There was no damage to either the container or the item. The container met the test requirements. (see Appendix 3, Table 1 and Waveforms.)

TEST SEQUENCE 5 – Lateral Impact (Pendulum Impact)

Procedure – Upon completion of the rotational drops, the container was placed on the pendulum test apparatus and impacted once on each side. The container impact velocity was 2.2 m/sec. (see Appendix 2, Figure 11.)

Results – All recorded impacts were less than or equal to the maximum allowed 20 Gs. There was no damage to either the container or the item. The container met the test requirements. (see Appendix 3, Table 1 and Waveforms.)

TEST SEQUENCE 6 – Leak Test

Procedure – Test Sequence 1 was repeated.

Results – The container passed the leak test with a leak rate less than the maximum allowed rate of 0.35 kPa (0.05 psi) per hour.

TEST CONCLUSIONS – No damage occurred during the above testing to the container, isolation system or test item. All impact levels are well below the item fragility limit of 20 Gs. Therefore, the container and mounting system do provide adequate protection for the antenna.

FIT & FUNCTION TESTING

Fit and function testing was completed on site at AFPTEF with the antenna and waveguide that was supplied for prototype testing. The packaging process was demonstrated to Robins AFB and Hurlbert Field personnel during the testing phase of the project.

CONCLUSIONS

The CNU-682/E aluminum container passed all tests and was accepted by the users at Robins AFB. The container met all the user's requirements. The container can protect a TFR Antenna during world-wide transportation and storage. The container will save the Air Force hundreds of thousands of dollars in O&M costs.

RECOMMENDATIONS

Twenty-five CNU 682/E containers have been procured, manufactured, and delivered. AFPTEF recommends that new containers be procured and delivered as needed to avoid future damage to antennas, thus mitigating overall shipping risks. All fiberglass containers for the TFR Antenna should be replaced.

APPENDIX 1: Test Plan

AF PACKAGING TECHNOLOGY AND ENGINEERING FACILITY (Container Test Plan)					AFPTEF PROJECT NUMBER: 05-P-107	
CONTAINER SIZE (L x W x D inches) INTERIOR: 38 X 25.2 X 23.7	EXTERIOR: 41.5 X 28.8 X 28.5	WEIGHT GROSS: 218 lb	ITEM: 36 lb	CUBE (CU. F) 19.7	QUANTITY: 1	DATE: 30 Aug 05
ITEM NAME: Combat Talon I TFR Antenna				MANUFACTURER:		
CONTAINER NAME: Reusable Shipping & Storage Container					CONTAINER COST:	
PACK DESCRIPTION: Extruded Aluminum Cntr., Aluminum Cradle, Helical Isolators, Test Load of a CTI TFR Antenna						
CONDITIONING: As noted below						

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRU-MENTATION
		NOTE No damage to contents is acceptable and Package must be in serviceable condition. Serviceable means remains sealed, with no deformities, etc.		
		Quality Conformance Tests		
1.	**Examination of Product.**			
	SAE ARP 1967 Par. 4.5.1 Table I	Container shall be carefully examined to determine conformance with material, workmanship, and requirements as specified in Table and drawings.	Ambient temp.	Visual Inspection (VI)
2.	**Weight Test.**			
	SAE ARP 1967 Par. 4.5.8.3.7	Container shall be weighed.	Ambient temp.	Scale
		Performance Tests		
3.	**Leak Test.**			
	SAE ARP 1967 Par. 4.5.2	Pneumatic pressure at 1.5 psi and vacuum retention at 1.5 psi. After temperature stabilization, pressure drop shall not exceed 0.05 psi per hour.	Ambient temp.	Pressure Transducer (PT)

COMMENTS:	
PREPARED BY: Matthew P. Bozzuto, Mechanical Engineer	APPROVED BY: Robbin L. Miller, Chief AFPTEF

PAGE 1 OF 3

AF PACKAGING TECHNOLOGY AND ENGINEERING FACILITY (Container Test Plan)

AFPTEF PROJECT NUMBER: 05-P-107

CONTAINER SIZE (L x W x D inches) INTERIOR:	EXTERIOR:	WEIGHT GROSS:	ITEM:	CUBE (CU. f)	QUANTITY:	DATE:
38 X 25.2 X 23.7	41.5 X 28.8 X 28.5	218 lb	36 lb	19.7	1	30 Aug 05

ITEM NAME: Combat Talon I TFR Antenna

MANUFACTURER:

CONTAINER NAME: Reusable Shipping & Storage Container

CONTAINER COST:

PACK DESCRIPTION: Extruded Aluminum Cntr., Aluminum Cradle, Helical Isolators, Test Load of a CTI TFR Antenna

CONDITIONING: As noted below

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRU-MENTATION
4.	**Rotational Drop Tests (Ambient Temperature).**			
	SAE ARP 1967 Par. 4.5.3 ASTM D 4169 ASTM D 6179 Methods A&B	Drop height shall be 30 in. Item shall not sustain more than 20Gs. Drop 30 in. for weight between 150 - 250 lb.	Ambient temp. One drop on all bottom corners (4 drops) and one drop on all edges (4 drops).	VI Tri-axial Accelerometer
5.	**Lateral Impact Test (Ambient Temperature).**			
	SAE ARP 1967 Par. 4.5.6 ASTM D 4169 ASTM D 880 Procedure B	Impact velocity 7.3 ft/s. Item shall not sustain more than 20Gs.	Ambient temp. One impact on each end and one on each side (4 impacts).	VI Tri-axial Accelerometer
6.	**Vibration Test.**			
a.	**SAE ARP 1967 Par. 4.5.5 ASTM D 4169 ASTM D 999**	The container shall be vibrated from 5 Hz to 50 Hz at a sweep rate of one half octave per minute with a total sweep time of 7.5 minutes. Container shall then be vibrated for 30 minutes at the predominant resonance. Input excitation shall be 0.125 in double amplitude or 1 G limits.	Ambient temp. Rigidly attach container to exciter	VI Tri-axial Accelerometer
b.	**SAE ARP 1967 Par. 4.5.5 ASTM D 4169 ASTM D 999 Method A**	Container shall be vibrated IAW ASTM D 4169, Method D 999 for not less that two hours.	Ambient temp. Blocking shall be used to keep cntr. in place, do not restrict vertical or rotational movement	VI Tri-axial Accelerometer

COMMENTS:

PREPARED BY: Matthew P. Bozzuto, Mechanical Engineer

APPROVED BY: Robbin L. Miller, Chief AFPTEF

PAGE 2 OF 3

AF PACKAGING TECHNOLOGY AND ENGINEERING FACILITY (Container Test Plan)						**AFPTEF PROJECT NUMBER:** 05-P-107	
CONTAINER SIZE (L x W x D inches) **INTERIOR:** 38 X 25.2 X 23.7	**EXTERIOR:** 41.5 X 28.8 X 28.5	**WEIGHT** **GROSS:** 218 lb	**ITEM:** 36 lb	**CUBE (CU. F)** 19.7		**QUANTITY:** 1	**DATE:** 30 Aug 05
ITEM NAME: Combat Talon I TFR Antenna				**MANUFACTURER:**			
CONTAINER NAME: Reusable Shipping & Storage Container						**CONTAINER COST:**	
PACK DESCRIPTION: Extruded Aluminum Cntr., Aluminum Cradle, Helical Isolators, Test Load of a CTI TFR Antenna							
CONDITIONING: As noted below							

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRU-MENTATION
7.	**Leak Test.** **SAE ARP 1967 Par. 4.5.2**	Pneumatic pressure at 1.5 psi and vacuum retention at 1.5 psi. After stabilization, pressure drop shall not exceed 0.05 psi per hour.	Ambient temp.	Pressure Transducer (PT)

COMMENTS:	
PREPARED BY: Matthew P. Bozzuto, Mechanical Engineer	**APPROVED BY:** Robbin L. Miller, Chief AFPTEF

PAGE 3 OF 3

APPENDIX 2: Fabrication & Testing Photographs

Figure 1. The finished container includes many important features.

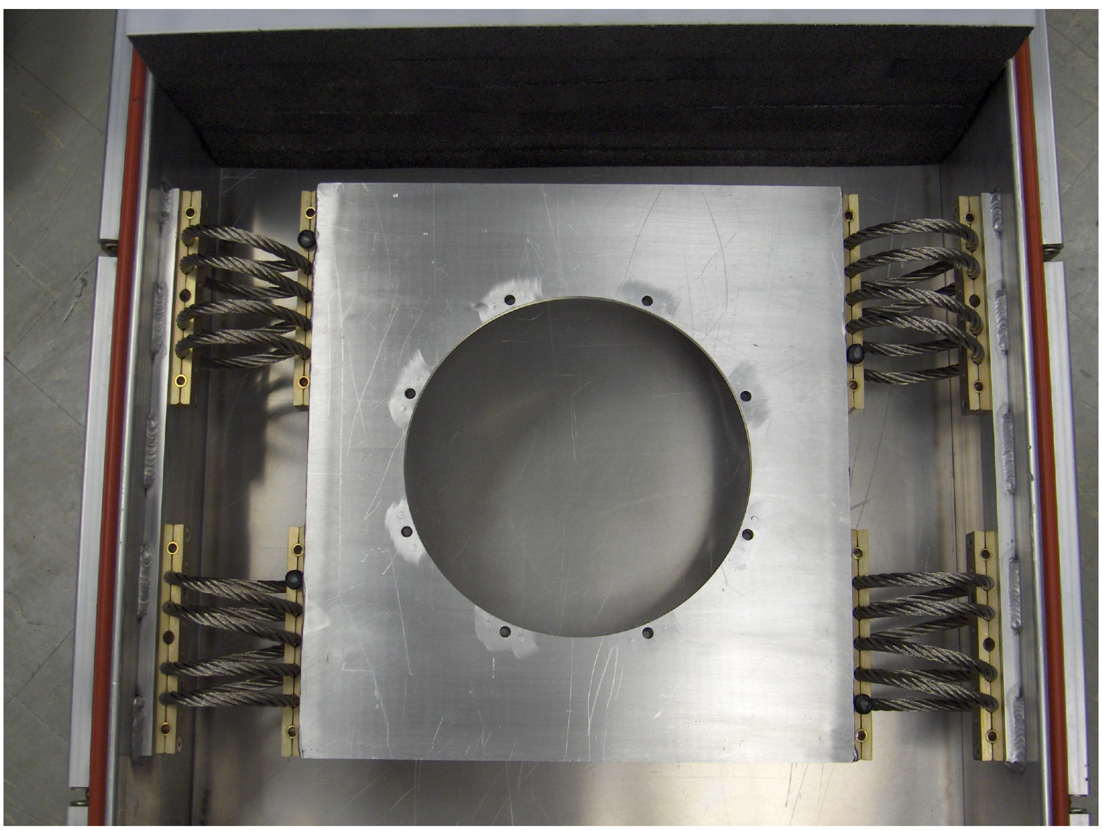


Figure 2. Four helical steel isolators suspend the aluminum cradle to provide shock and vibration isolation.

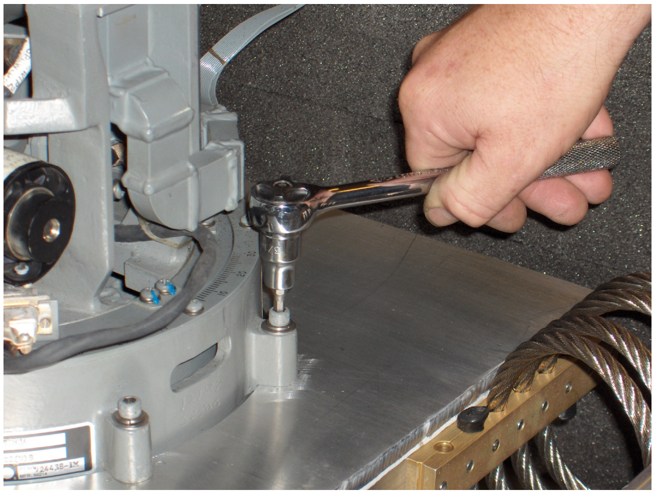


Figure 3. Eight captive screws are used to attach the antenna to the cradle system.

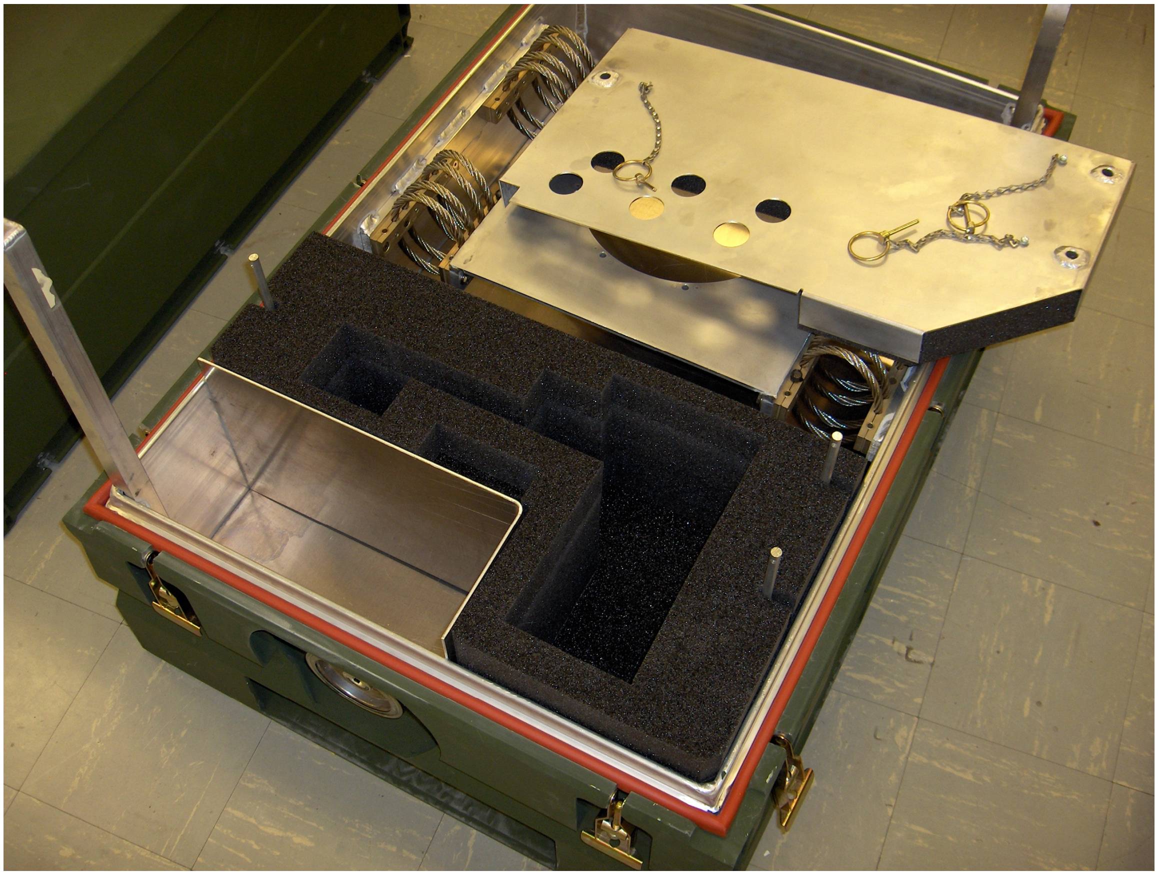


Figure 4. The waveguide rests inside a cutout in the foam cushion.

Figure 5. Three linch pins hold the waveguide lid in place.

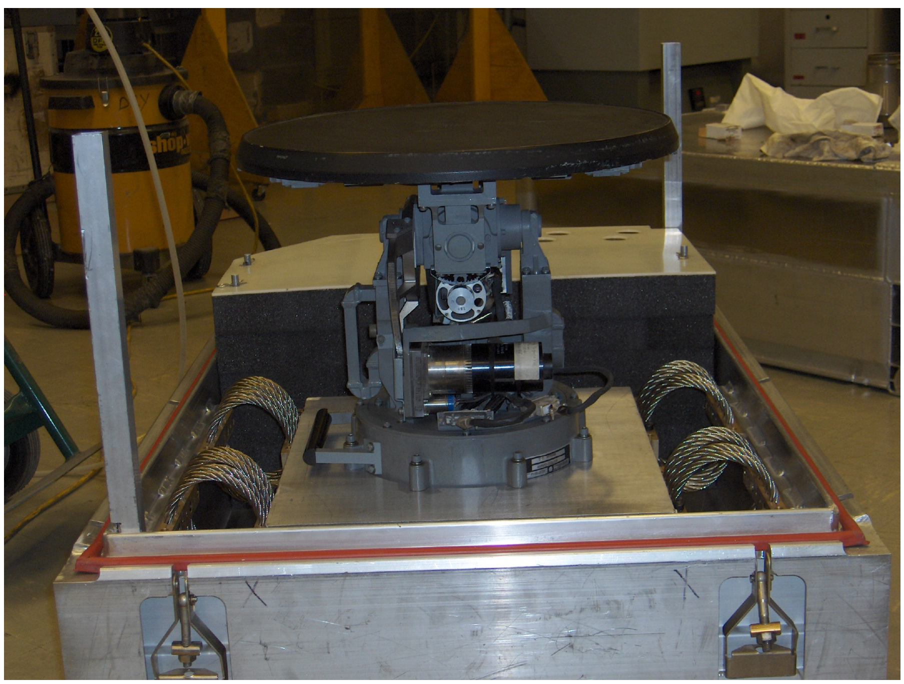


Figure 6. TFR Antenna in container base.

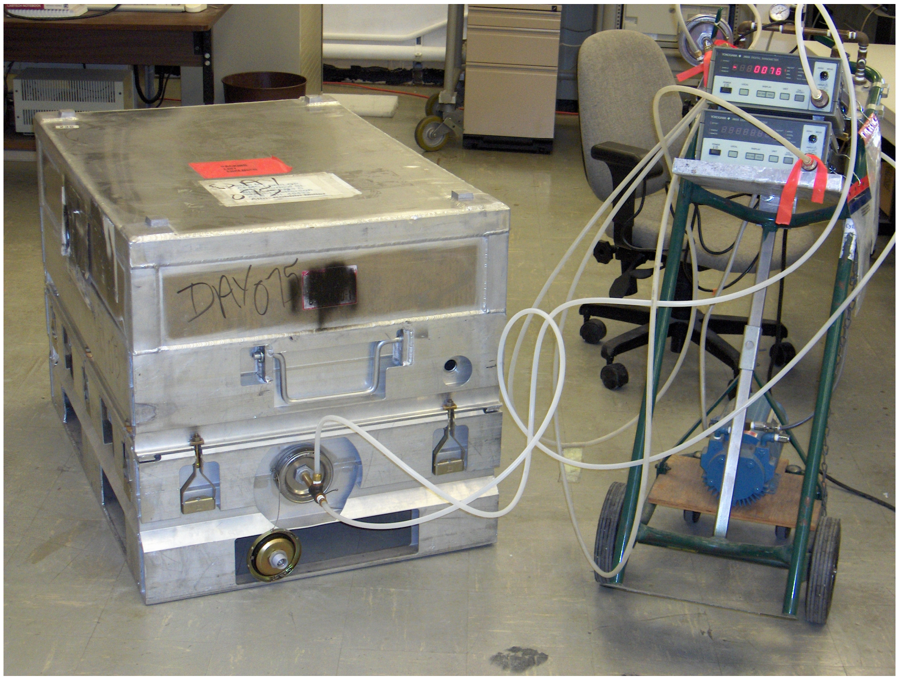


Figure 7. Pressure Test.

Figure 8. Resonance Dwell Test.

Figure 9. Repetitive Shock Test.

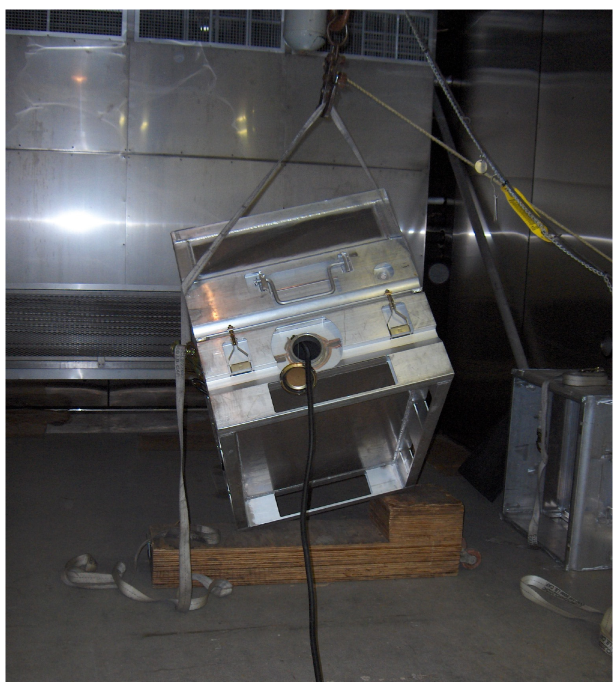


Figure 10. Cornerwise Rotational Drop.

Figure 11. Pendulum Impact Test.

APPENDIX 3: Test Data

Table 1. Impact Test Summary

IMPACT TYPE	TEST TEMPERATURE	IMPACT LOCATION	RESULTANT PEAK G
ROTATIONAL - CORNER	ambient	forward-left	16
ROTATIONAL - CORNER	ambient	forward-right	12
ROTATIONAL - CORNER	ambient	aft-left	9
ROTATIONAL - CORNER	ambient	aft-right	8
ROTATIONAL - EDGE	ambient	forward-bottom	16
ROTATIONAL - EDGE	ambient	aft-bottom	9
ROTATIONAL - EDGE	ambient	left-bottom	15
ROTATIONAL - EDGE	ambient	right-bottom	11
LATERAL IMPACT - FACE	ambient	forward	14
LATERAL IMPACT - FACE	ambient	aft	13
LATERAL IMPACT - FACE	ambient	left	**
LATERAL IMPACT - FACE	ambient	right	20

** The waveform for this drop was not recorded, however the resultant peak G level is known to be less than 20 Gs.

Table 2. Container Resonant Frequency and Transmissibility Values.

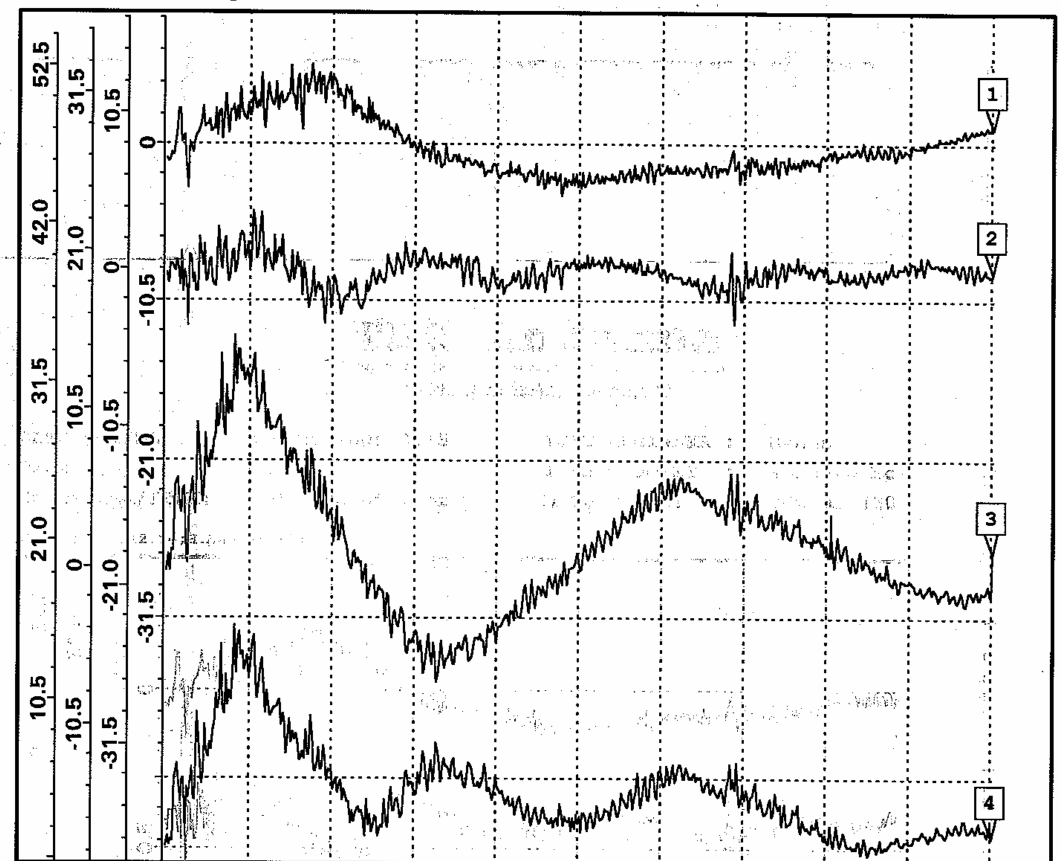
TEST TEMPERATURE	DWELL TIME	RESONANT FREQUENCY	TRANSMISSIBILITY
Ambient	5 min	10.75 Hz	1.5
Ambient	15 min	10.92 Hz	1.6
Ambient	30 min	10.92 Hz	1.4

TFR Antenna

ROTATIONAL IMPACT

DATE / TIME :	Sep 20 2005 9:15	TEST ENGINEER :	Evans
Test Type :	Edgewise	IMPACT POINT :	Forward Bottom Edge
CONTAINER/ITEM:	TFR Al container	DROP HEIGHT :	762 mm (30 in.)

V. Angle: 112.24;H.Angle: 104.89;



Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	210.	mS	-0.88 g's	5.88 g's	-20.02 In/s	26 mS	1	2
2	210.	mS	-0.55 g's	5.21 g's	-13.91 In/s	26 mS	1	2
3	210.	mS	2.07 g's	15.46 g's	174.99 In/s	26 mS	1	2
R	210.	mS	2.32 g's	15.72 g's	176.68 In/s	26 mS	1	2

PEAK G RESULTANT VALUE = 16 Gs; PEAK G (Z) = 15 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse); Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

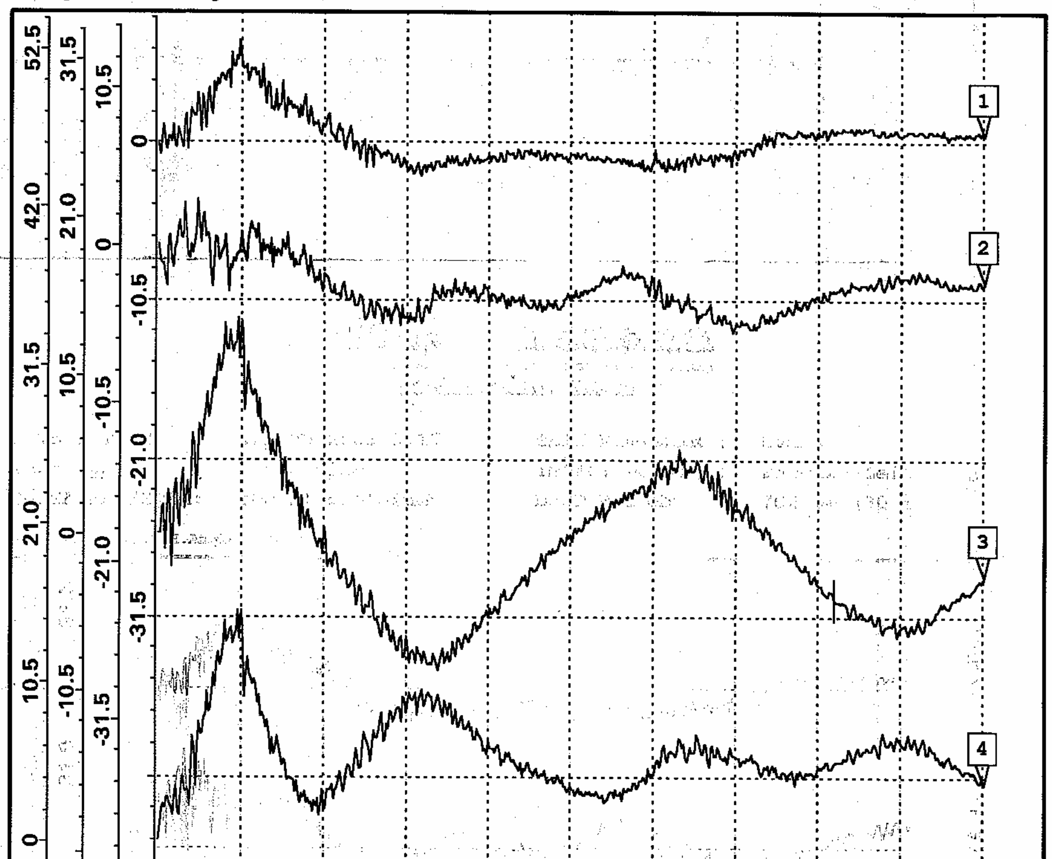
GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

ROTATIONAL IMPACT

DATE / TIME :	Sep 20 2005 9:17	TEST ENGINEER :	Evans
Test Type :	Cornerwise	IMPACT POINT :	Forward-Left Corner
CONTAINER/ITEM:	TFR A1 container	DROP HEIGHT :	762 mm (30 in.)

V. Angle: 83.21;H.Angle: 235.08;



Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	214.	mS	0.62 g's	6.99 g's	8.14 In/s	26 mS	1	2
2	214.	mS	-3.00 g's	-5.84 g's	-235.09 In/s	26 mS	1	2
3	214.	mS	-4.29 g's	15.64 g's	10.75 In/s	26 mS	1	2
R	214.	mS	5.27 g's	16.32 g's	235.48 In/s	26 mS	1	2

PEAK G RESULTANT VALUE = 16 Gs; PEAK G (Y) = 16 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse);
Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

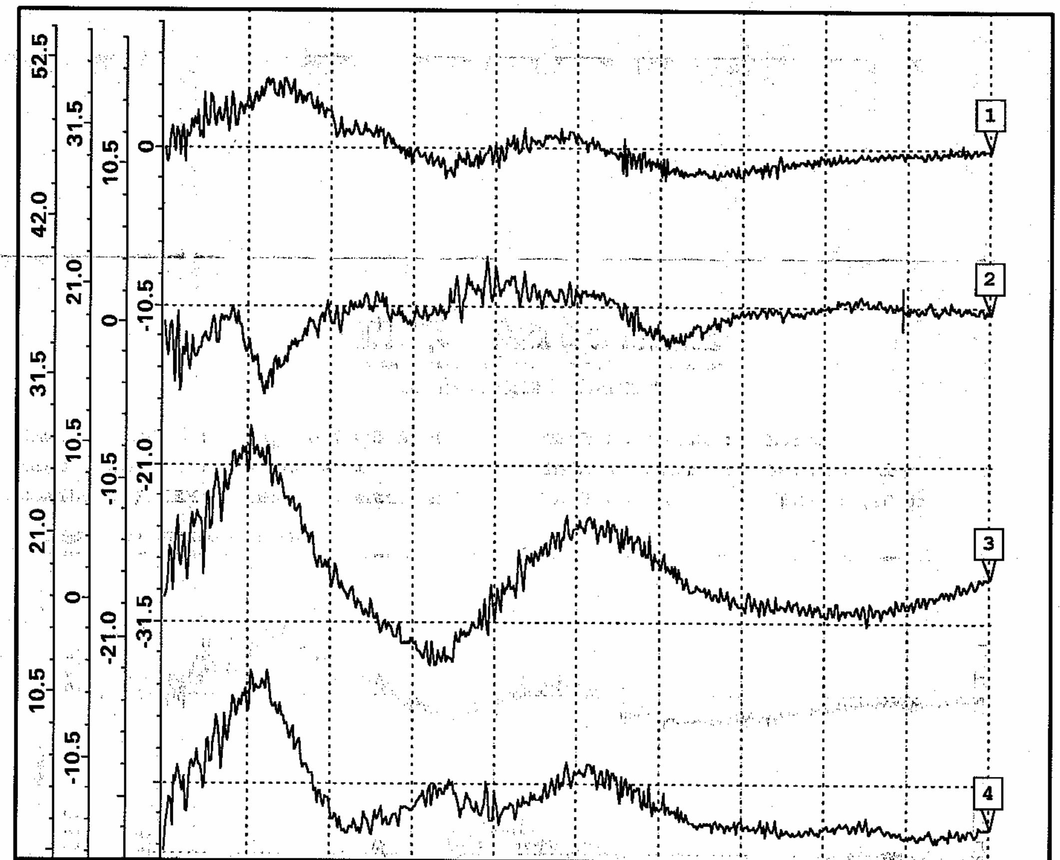
GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

ROTATIONAL IMPACT

DATE / TIME :	Sep 20 2005 9:20	TEST ENGINEER :	Evans
Test Type :	Cornerwise	IMPACT POINT :	Forward-Right Corner
CONTAINER/ITEM:	TFR A1 container	DROP HEIGHT :	762 mm (30 in.)

V. Angle: 114.67;H.Angle: 356.67;



	Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
○	1	233.	mS	-0.43 g's	5.13 g's	17.90 In/s	26 mS	1	2
◉	2	233.	mS	0.93 g's	-5.68 g's	39.95 In/s	26 mS	1	2
○	3	233.	mS	-0.05 g's	11.75 g's	153.99 In/s	26 mS	1	2
○	R	233.	mS	1.02 g's	12.11 g's	160.09 In/s	26 mS	1	2

PEAK G RESULTANT VALUE = 12 Gs; PEAK G (Y) = 12 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse);
Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

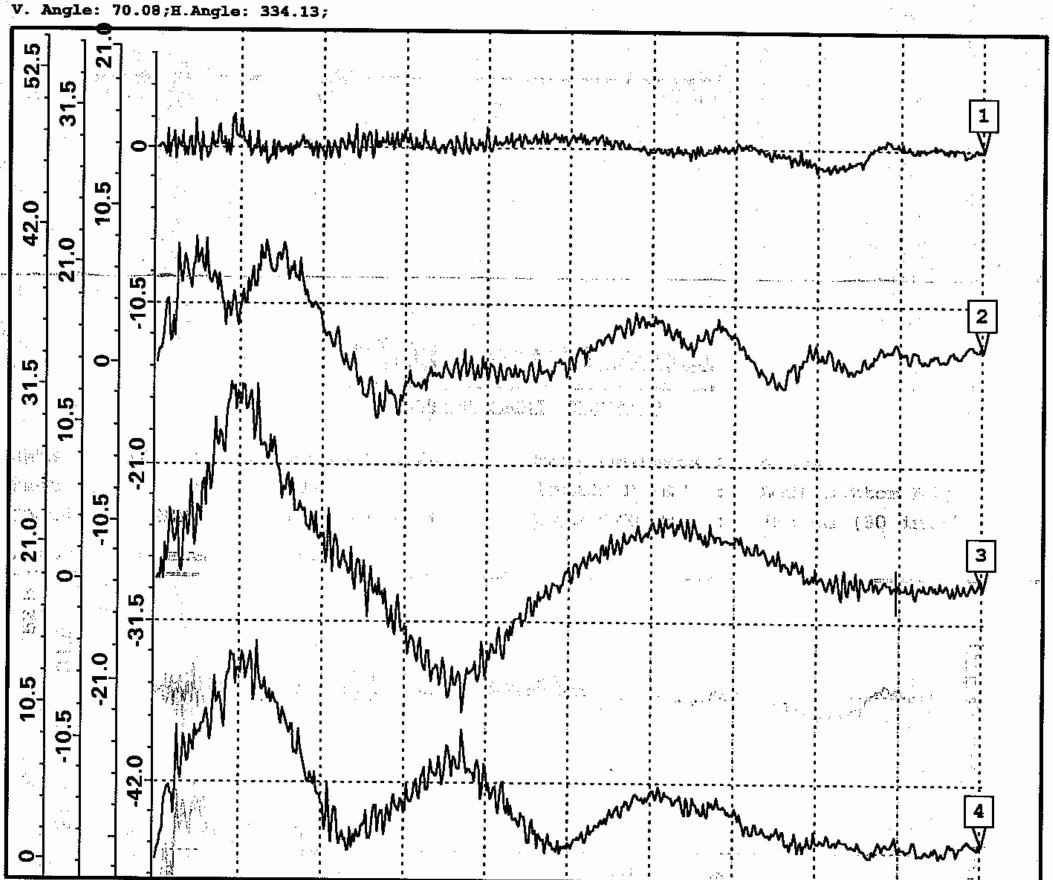
GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

ROTATIONAL IMPACT

DATE / TIME :	Sep 20 2005 9:26	TEST ENGINEER :	Evans
Test Type :	Edgewise	IMPACT POINT :	Left Bottom Edge
CONTAINER/ITEM:	TFR Al container	DROP HEIGHT :	762 mm (30 in.)

V. Angle: 70.08;H.Angle: 334.13;



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	233. mS	0.57 g's	2.25 g's	12.70 In/s	26 mS	1	2
2	233. mS	1.41 g's	8.61 g's	123.50 In/s	26 mS	1	2
3	233. mS	-0.68 g's	13.34 g's	120.45 In/s	26 mS	1	2
R	233. mS	1.66 g's	14.59 g's	172.98 In/s	26 mS	1	2

PEAK G RESULTANT VALUE = 15 Gs; PEAK G (Y) = 13 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse);
Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

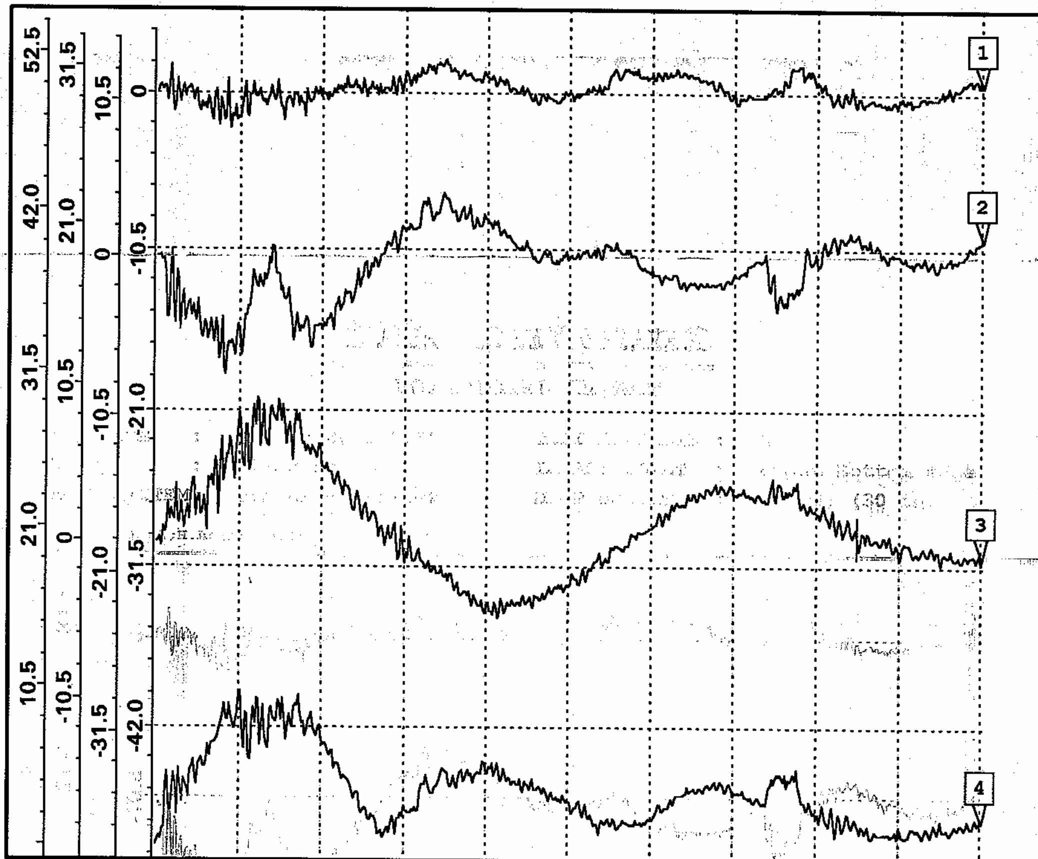
GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

ROTATIONAL IMPACT

DATE / TIME : Sep 20 2005 9:30
Test Type : Edgewise
CONTAINER/ITEM: TFR Al container
TEST ENGINEER : Evans
IMPACT POINT : Right Bottom Edge
DROP HEIGHT : 762 mm (30 in.)

V. Angle: 101.65;H.Angle: 9.34;



Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	221.	mS	-0.31 g's	-2.45 g's	27.54 In/s	26 mS	1	2
2	221.	mS	1.48 g's	-8.22 g's	-75.88 In/s	26 mS	1	2
3	221.	mS	0.24 g's	10.39 g's	119.04 In/s	26 mS	1	2
R	221.	mS	1.54 g's	10.50 g's	143.82 In/s	26 mS	1	2

PEAK G RESULTANT VALUE = 10 Gs; PEAK G (Y) = 10 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse); Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

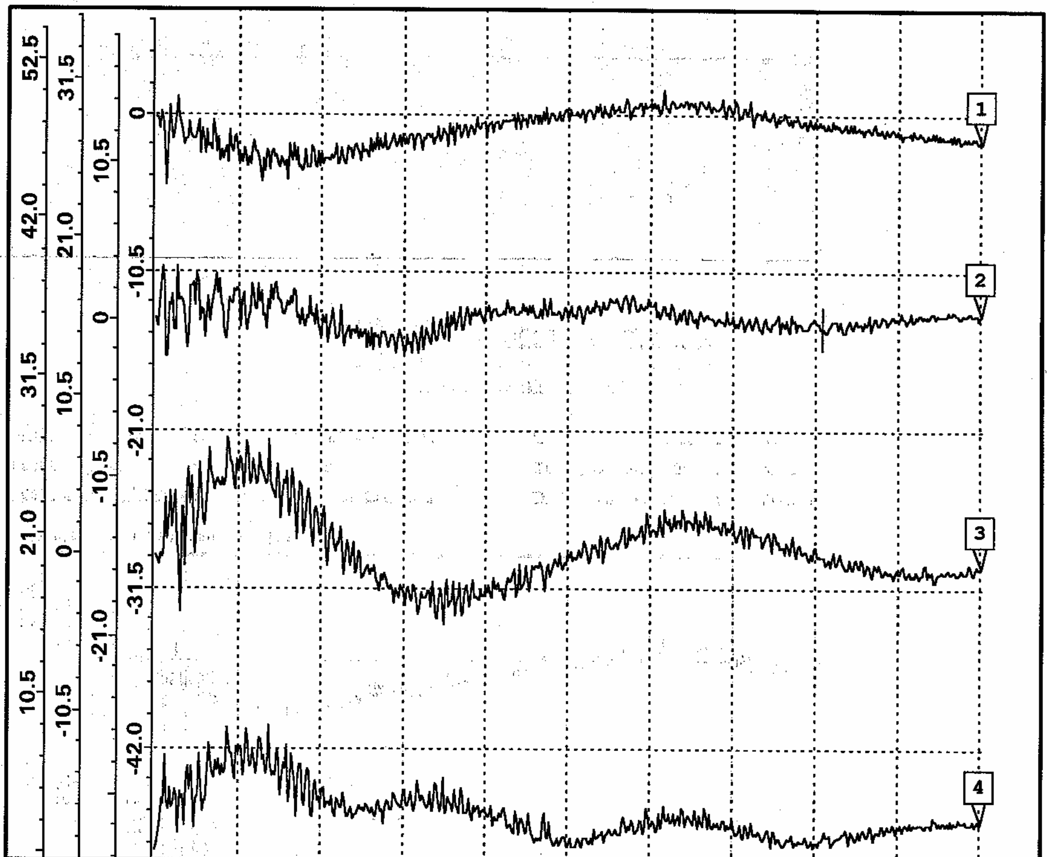
GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

ROTATIONAL IMPACT

DATE / TIME	:	Sep 20 2005 9:07	TEST ENGINEER	:	Evans
Test Type	:	Edgewise	IMPACT POINT	:	Aft Bottom Edge
CONTAINER/ITEM:		TFR A1 container	DROP HEIGHT	:	762 mm (30 in.)

V. Angle: 133.71;H.Angle: 199.64;



Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div		Hexp	Vexp
1	210.	mS	-0.62 g's	-4.87 g's	-75.75 In/s	26	mS	1	2
2	210.	mS	-0.61 g's	4.36 g's	14.02 In/s	26	mS	1	2
3	210.	mS	-0.22 g's	7.88 g's	61.62 In/s	26	mS	1	2
R	210.	mS	0.89 g's	8.61 g's	98.65 In/s	26	mS	1	2

PEAK G RESULTANT VALUE = 8 Gs; PEAK G (Z) = 9 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse);
Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

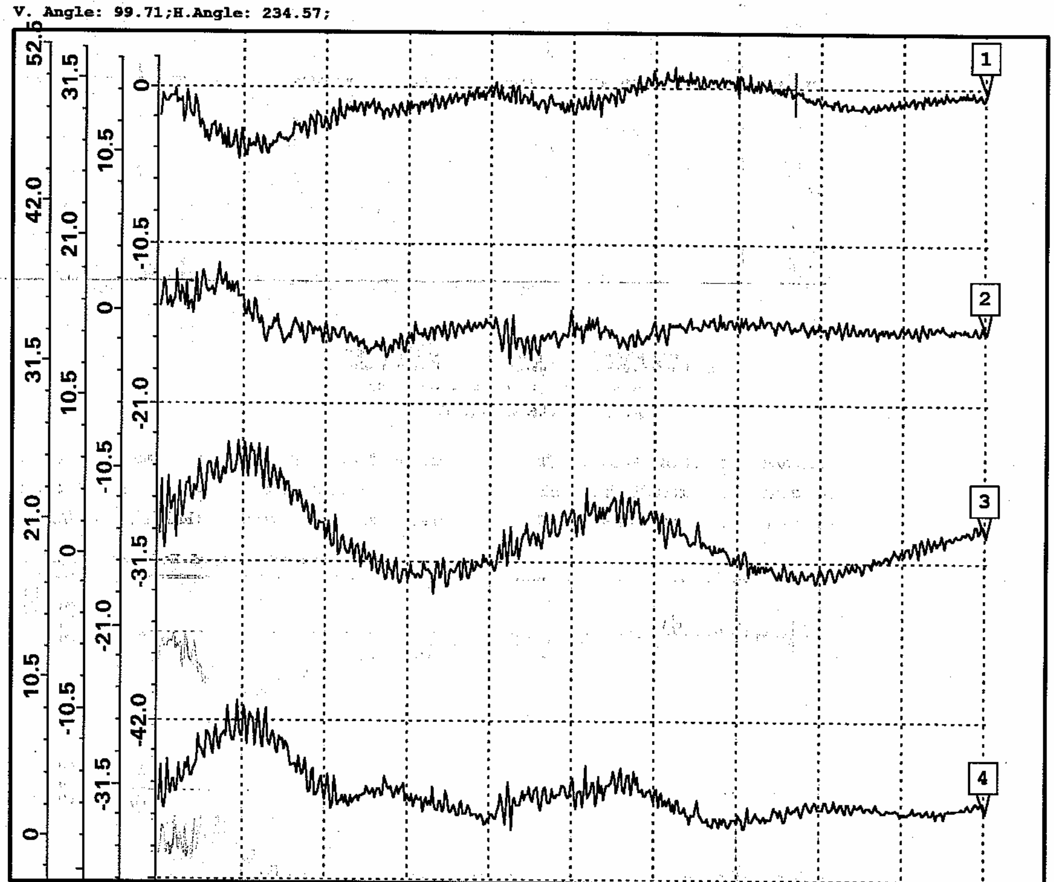
GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

ROTATIONAL IMPACT

DATE / TIME :	Sep 20 2005 9:09	TEST ENGINEER :	Evans
Test Type :	Cornerwise	IMPACT POINT :	Aft-Left Corner
CONTAINER/ITEM:	TFR A1 container	DROP HEIGHT :	762 mm (30 in.)

V. Angle: 99.71;H.Angle: 234.57;



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	200. mS	-0.33 g's	-5.36 g's	-87.97 In/s	26 mS	1	2
2	200. mS	-1.13 g's	-3.76 g's	-85.96 In/s	26 mS	1	2
3	200. mS	-1.59 g's	7.64 g's	117.94 In/s	26 mS	1	2
R	200. mS	1.99 g's	9.24 g's	170.40 In/s	26 mS	1	2

PEAK G RESULTANT VALUE = 9 Gs; PEAK G (Z) = 9 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse);
Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

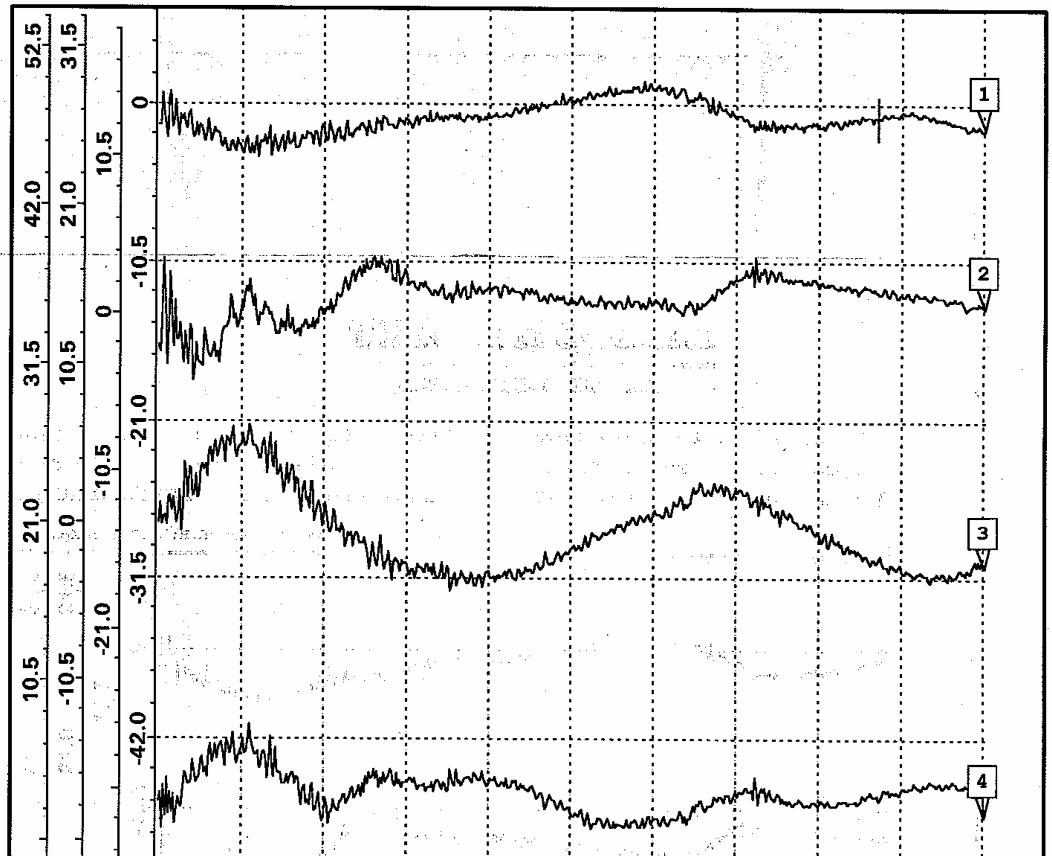
GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

ROTATIONAL IMPACT

DATE / TIME :	Sep 20 2005 9:11	TEST ENGINEER :	Evans
Test Type :	Cornerwise	IMPACT POINT :	Aft-Right Corner
CONTAINER/ITEM:	TFR A1 container	DROP HEIGHT :	762 mm (30 in.)

V. Angle: 107.35;H.Angle: 298.40;



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	227. mS	-0.91 g's	-3.85 g's	-80.97 In/s	26 mS	1	2
2	227. mS	1.39 g's	-4.80 g's	83.68 In/s	26 mS	1	2
3	227. mS	-2.57 g's	6.81 g's	-7.43 In/s	26 mS	1	2
R	226. mS	3.05 g's	7.69 g's	116.68 In/s	26 mS	1	2

PEAK G RESULTANT VALUE = 8 Gs; PEAK G (Z) = 7 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse);
Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

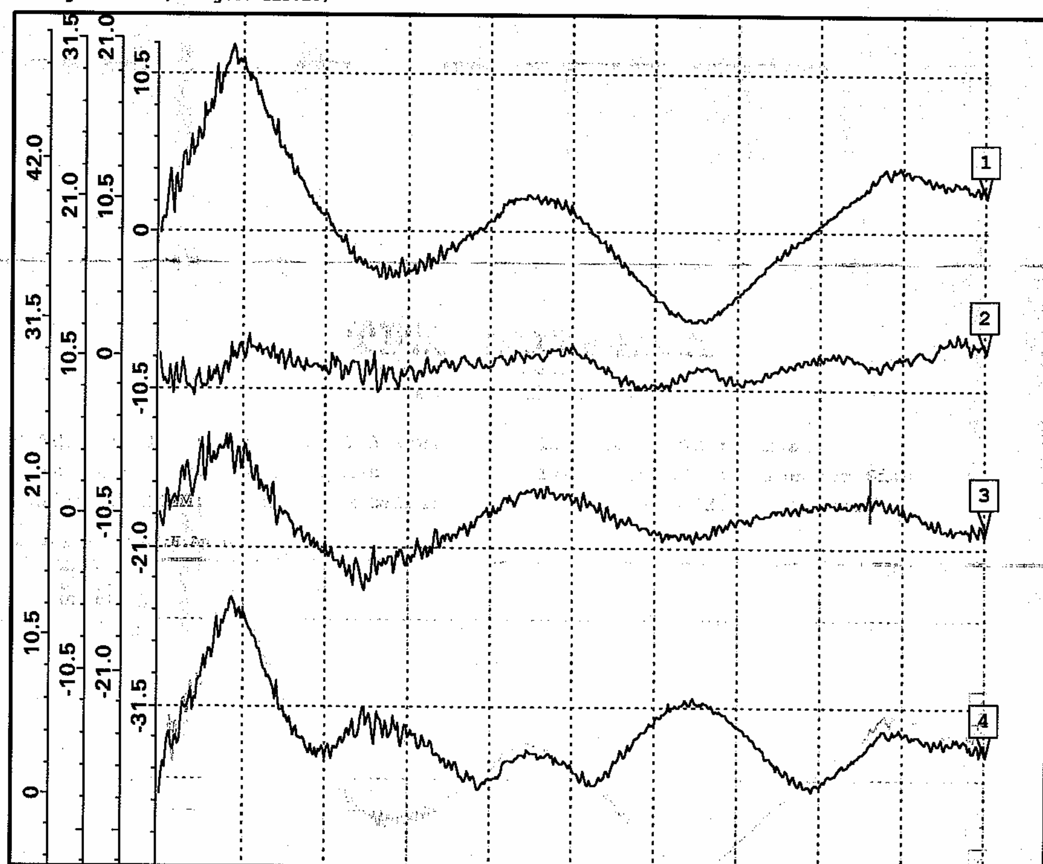
GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

PENDULOM IMPACT

DATE / TIME :	Sep 20 2005 9:42	TEST ENGINEER :	Evans
Test Type :	Side Impact	IMPACT POINT :	Forward Side
CONTAINER/ITEM:	TFR A1 container	IMPACT VELOCTY:	2.19 m/s

V. Angle: 18.86;H.Angle: 123.16;



	Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div		Hexp	Vexp
○	1	224.	mS	3.27 g's	12.92 g's	46.65 In/s	26	mS	1	2
○	2	224.	mS	-0.61 g's	-2.84 g's	-70.19 In/s	26	mS	1	2
◉	3	224.	mS	0.94 g's	-5.46 g's	-20.20 In/s	26	mS	1	2
○	R	224.	mS	3.46 g's	13.70 g's	86.67 In/s	26	mS	1	2

PEAK G RESULTANT VALUE = 13 Gs; PEAK G (X) = 14 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse);
Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

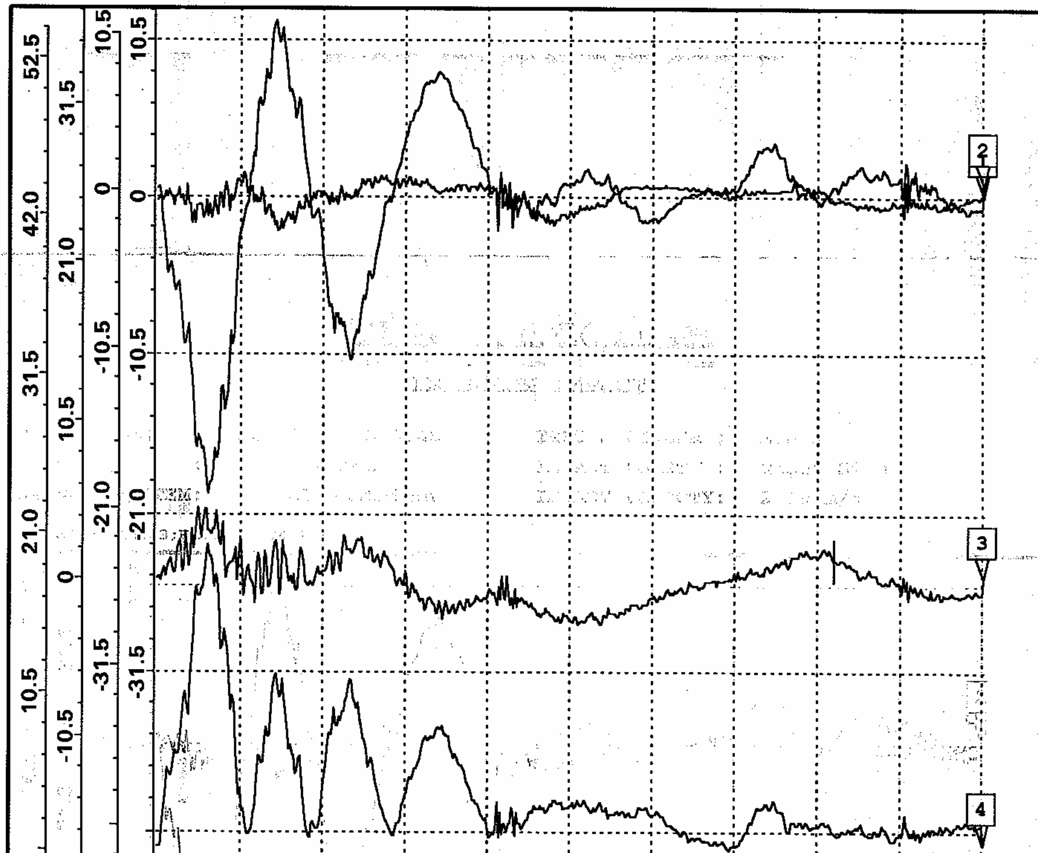
GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

PENDULOM IMPACT

DATE / TIME :	Sep 20 2005 9:46	TEST ENGINEER :	Evans
Test Type :	Side Impact	IMPACT POINT :	Right Side
CONTAINER/ITEM:	TFR Al container	IMPACT VELOCTY:	2.19 m/s

V. Angle: 104.53;H.Angle: 74.23;



	Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div		Hexp	Vexp
○	1	214.	mS	-0.30 g's	-2.63 g's	12.86 In/s	26	mS	1	2
○	2	214.	mS	0.32 g's	-20.17 g's	-66.86 In/s	26	mS	1	2
◉	3	214.	mS	1.13 g's	5.06 g's	-19.14 In/s	26	mS	1	2
○	R	214.	mS	1.21 g's	20.45 g's	70.72 In/s	26	mS	1	2

PEAK G RESULTANT VALUE = 20 Gs; PEAK G (Y) = 20 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse);
Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

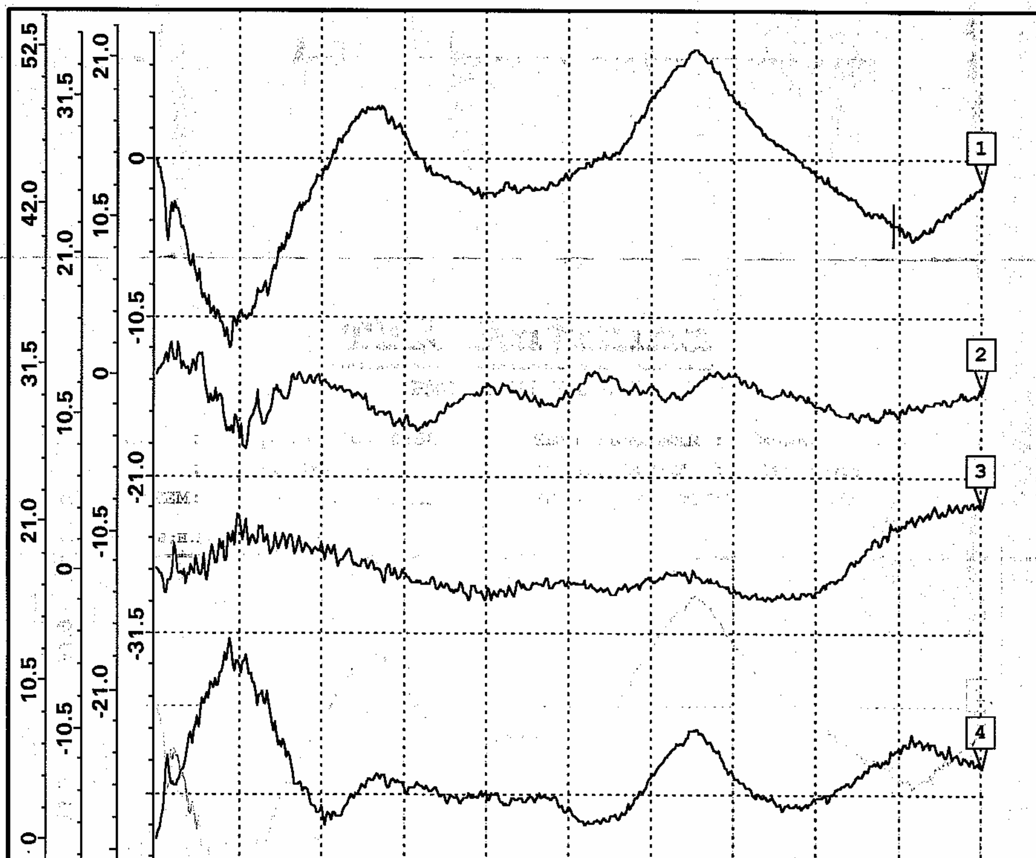
GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

PENDULOM IMPACT

DATE / TIME :	Sep 20 2005 9:58	TEST ENGINEER :	Evans
Test Type :	Side Impact	IMPACT POINT :	Aft Side
CONTAINER/ITEM:	TFR A1 container	IMPACT VELOCTY:	2.19 m/s

V. Angle: 139.78;H.Angle: 129.95;



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	232. mS	-4.34 g's	-12.64 g's	-90.92 In/s	26 mS	1	2
2	232. mS	-2.36 g's	-5.19 g's	-127.18 In/s	26 mS	1	2
3	232. mS	2.82 g's	3.89 g's	-18.95 In/s	26 mS	1	2
R	232. mS	5.69 g's	13.32 g's	157.48 In/s	26 mS	1	2

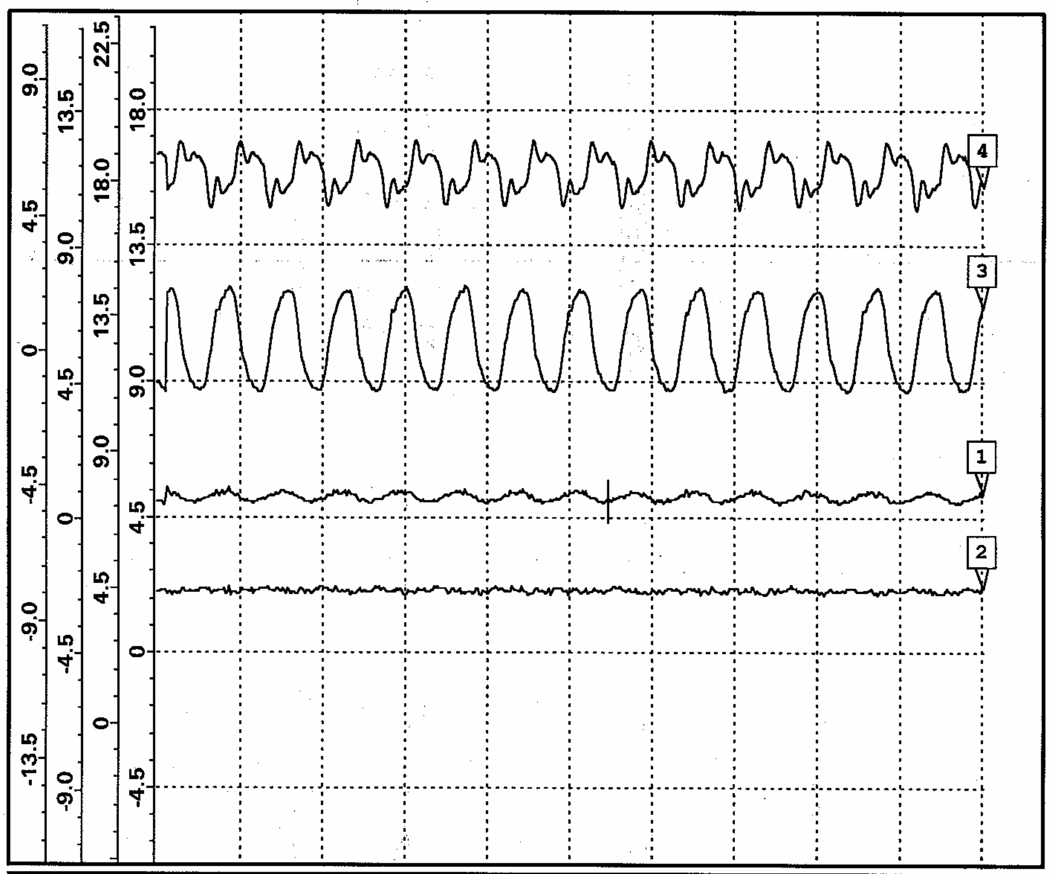
PEAK G RESULTANT VALUE = 13 Gs; PEAK G (Y) = 13 Gs.
ACCELEROMETER OUTPUT: Ch1 - X(longitudinal); Ch2 - Y(transverse); Ch3 - Z(vertical); Ch4 - resultant.
No visible damage.
ASTM D 4169, ASTM D 880, SAE ARP 1967.

GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

RESONANCE DWELL

DATE / TIME :	Sep 20 2005 10:53	TEST ENGINEER :	Evans
TEST TYPE :	Vibration	FREQUENCY :	10.75 Hz
CONTAINER/ITEM:	TFR A1 container	TEST TIME :	5 MIN



Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div		Hexp	Vexp
1	714.	mS	4.98 g's	5.48 g's	1417.67 In/s	131	mS	1	2
2	727.	mS	4.44 g's	4.63 g's	1230.22 In/s	131	mS	1	2
3	1.19	S	4.24 g's	7.82 g's	2691.41 In/s	131	mS	1	2
4	734.	mS	4.75 g's	7.07 g's	1689.40 In/s	131	mS	1	2

Accelerometer output: Ch1 - X(long.); Ch2 - Y(trans.); Ch3 - Z(vert.); Ch4 - table input.

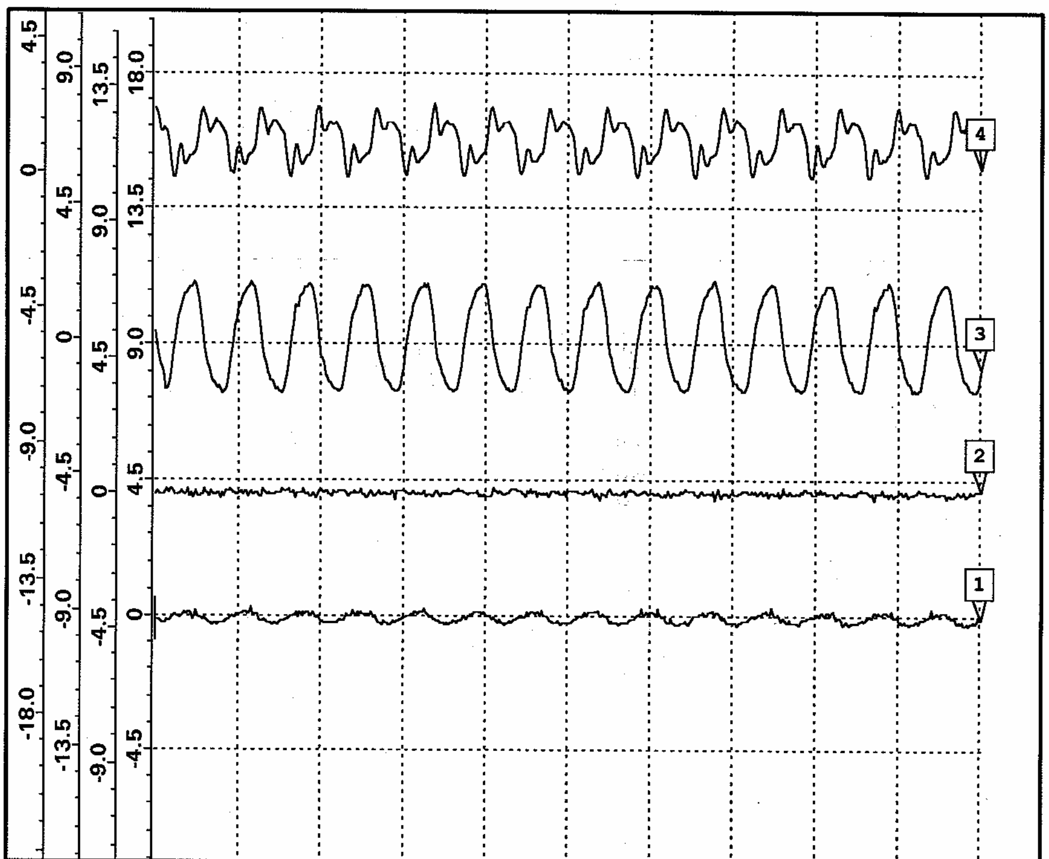
Aft side = desiccant port end. Cable aft. Ambient temperature and humdity.
ASTM D 4169, ASTM D 999, SAE ARP1967.

GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

RESONANCE DWELL

DATE / TIME :	Sep 20 2005 11:15	TEST ENGINEER :	Evans
TEST TYPE :	Vibration	FREQUENCY :	10.92 Hz
CONTAINER/ITEM:	TFR A1 container	TEST TIME :	15 min



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	0.00 uS	-0.12 g's	-0.12 g's	0.00 In/s	131 mS	1	2
2	440. mS	-0.05 g's	0.28 g's	1.71 In/s	131 mS	1	2
3	440. mS	0.31 g's	-1.92 g's	1.99 In/s	131 mS	1	2
4	437. mS	2.05 g's	2.28 g's	170.46 In/s	131 mS	1	2

Accelerometer output: Ch1 - X(long.); Ch2 - Y(trans.); Ch3 - Z(vert.); Ch4 - table input.

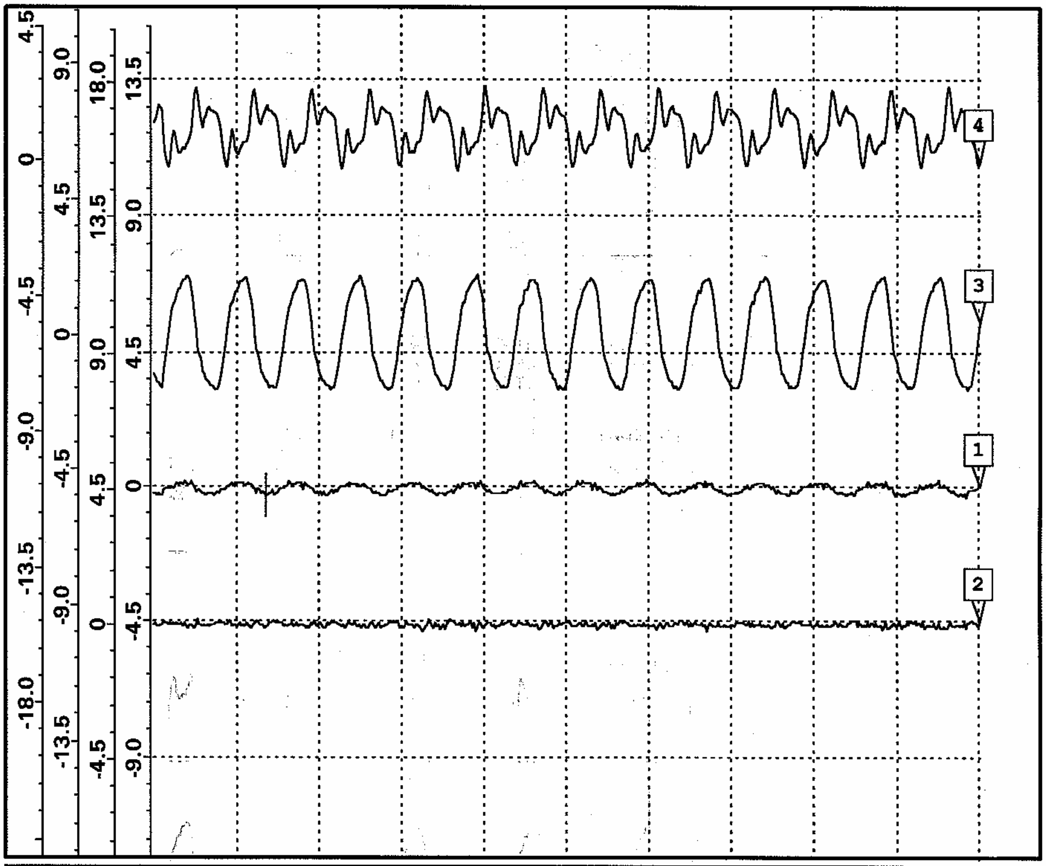
Aft side = desiccant port end. Cable aft. Ambient temperature and humdity.
ASTM D 4169, ASTM D 999, SAE ARP1967.

GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

RESONANCE DWELL

DATE / TIME : Sep 20 2005 11:15
TEST TYPE : Vibration
CONTAINER/ITEM: TFR A1 container
TEST ENGINEER : Evans
FREQUENCY : 10.92 Hz
TEST TIME : 30 min



Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div		Hexp	Vexp
1	176.	mS	-0.25 g's	-0.40 g's	-3.03 In/s	131	mS	1	2
2	176.	mS	-0.06 g's	-0.26 g's	1.68 In/s	131	mS	1	2
3	1.17	S	-0.81 g's	2.07 g's	-10.91 In/s	131	mS	1	2
4	176.	mS	1.72 g's	2.45 g's	70.28 In/s	131	mS	1	2

Accelerometer output: Ch1 - X(long.); Ch2 - Y(trans.); Ch3 - Z(vert.); Ch4 - table input. Test was halted and restarted at 15 min.

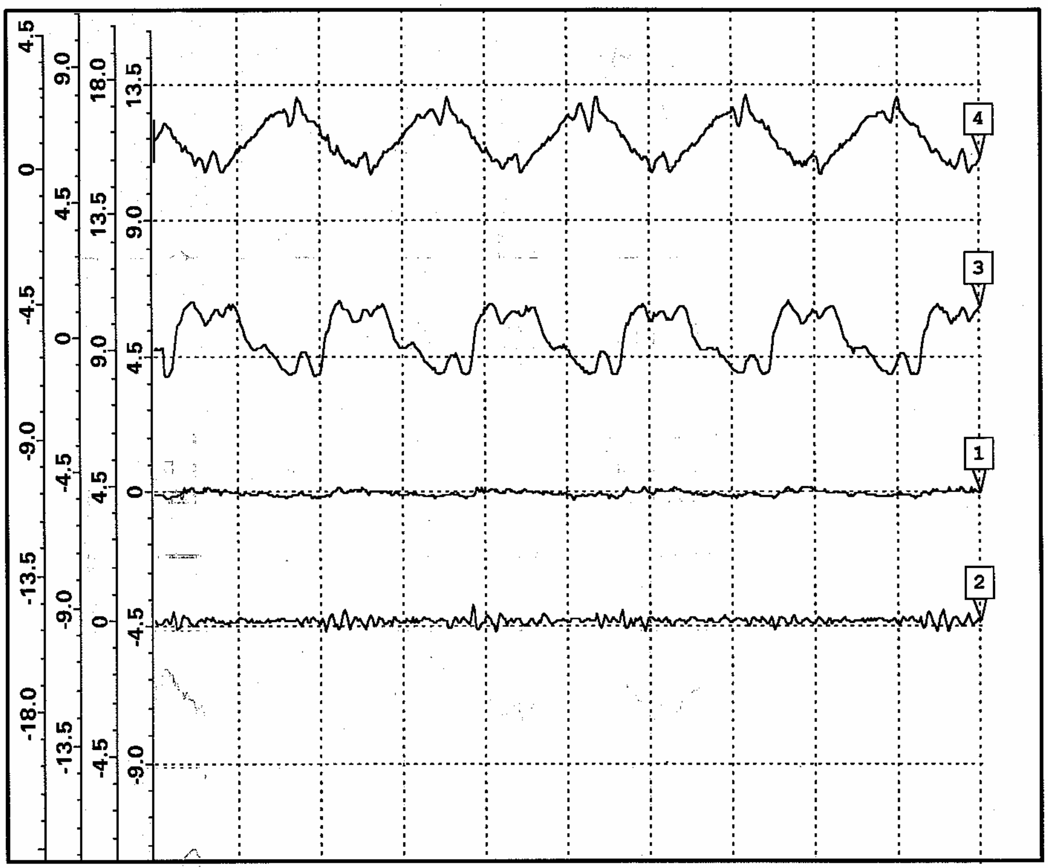
Aft side = desiccant port end. Cable aft. Ambient temperature and humdity.
ASTM D 4169, ASTM D 999, SAE ARP1967.

GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

REPETITIVE SHOCK

DATE / TIME :	Sep 20 2005 11:15	TEST ENGINEER :	Evans
TEST TYPE :	Vibration	FREQUENCY :	4.225 Hz
CONTAINER/ITEM:	TFR Al container	TEST TIME :	10 min



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	340. mS	0.01 g's	-0.30 g's	-5.12 In/s	131 mS	1	2
2	847. mS	0.12 g's	0.69 g's	4.26 In/s	131 mS	1	2
3	340. mS	0.72 g's	-1.36 g's	7.18 In/s	131 mS	1	2
4	0.00 uS	0.94 g's	0.94 g's	0.00 In/s	131 mS	1	2

Accelerometer output: Ch1 - X(long.); Ch2 - Y(trans.); Ch3 - Z(vert.); Ch4 - table input.

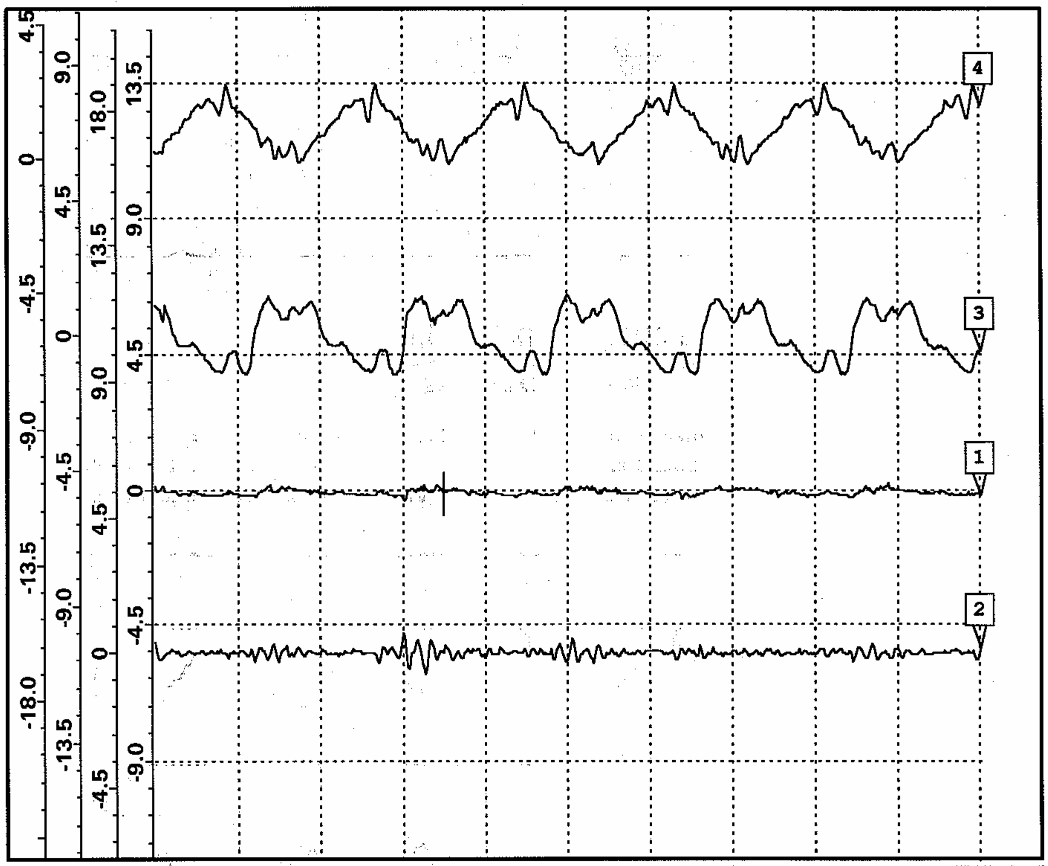
Aft side = desiccant port end. Cable aft. Ambient temperature and humdity.
ASTM D 4169, ASTM D 999, SAE ARP1967.

GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

REPETITIVE SHOCK

DATE / TIME :	Sep 20 2005 11:15	TEST ENGINEER :	Evans
TEST TYPE :	Vibration	FREQUENCY :	4.225 Hz
CONTAINER/ITEM:	TFR A1 container	TEST TIME :	60 min



Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div		Hexp	Vexp
1	455.	mS	-0.10 g's	-0.35 g's	-9.12 In/s	131	mS	1	2
2	2.56	mS	0.01 g's	0.40 g's	0.39 In/s	131	mS	1	2
3	455.	mS	0.78 g's	-1.36 g's	-13.20 In/s	131	mS	1	2
4	81.92	mS	1.93 g's	1.94 g's	34.13 In/s	131	mS	1	2

Accelerometer output: Ch1 - X(long.); Ch2 - Y(trans.); Ch3 - Z(vert.);
Ch4 - table input.

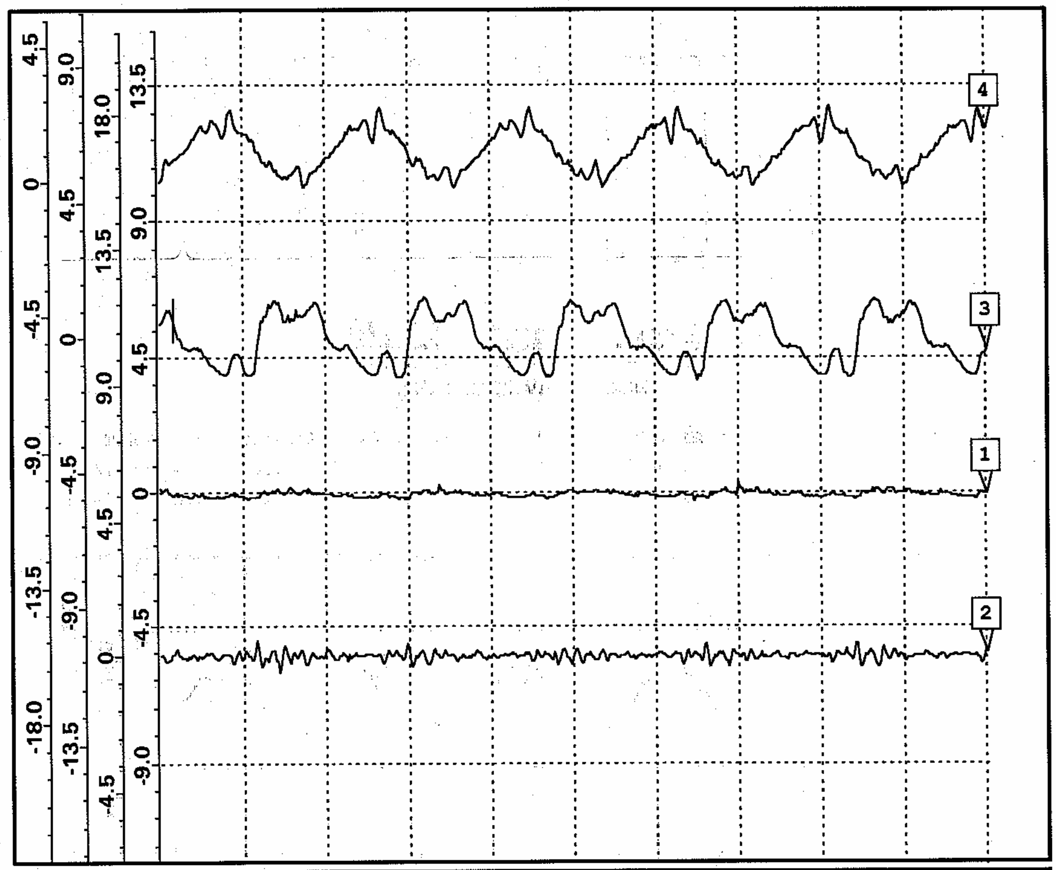
Aft side = desiccant port end. Cable aft. Ambient temperature and humdity.
ASTM D 4169, ASTM D 999, SAE ARP1967.

GHI SYSTEMS, INC. CAT SYSTEM

TFR Antenna

REPETITIVE SHOCK

DATE / TIME :	Sep 20 2005 11:15	TEST ENGINEER :	Evans
TEST TYPE :	Vibration	FREQUENCY :	4.225 Hz
CONTAINER/ITEM:	TFR A1 container	TEST TIME :	90 min



Ch.	Time		Curr Amp	Peak Amp	1st Int	Time/Div		Hexp	Vexp
1	460.	mS	0.05 g's	0.30 g's	-7.83 In/s	131	mS	1	2
2	460.	mS	0.09 g's	0.69 g's	4.00 In/s	131	mS	1	2
3	20.48	mS	0.53 g's	0.97 g's	6.18 In/s	131	mS	1	2
4	460.	mS	0.14 g's	2.62 g's	189.19 In/s	131	mS	1	2

Accelerometer output: Ch1 - X(long.); Ch2 - Y(trans.); Ch3 - Z(vert.); Ch4 - table input.

Aft side = desiccant port end. Cable aft. Ambient temperature and humdity.
ASTM D 4169, ASTM D 999, SAE ARP1967.

GHI SYSTEMS, INC. CAT SYSTEM

APPENDIX 4: Test Instrumentation

PRESSURE TEST EQUIPMENT - Test sequences 1 & 6

EQUIPMENT	MANUFACTURER	MODEL	SN	CAL. DATE
Digital Manometer	Yokogawa	2655	82DJ6009	August 05

ROUGH HANDLING TEST EQUIPMENT - Test sequences 2 - 5.

EQUIPMENT	MANUFACTURER	MODEL	SN	CAL. DATE
Shock Amplifier	Endevco	2775A	ER34	NA
Shock Amplifier	Endevco	2775A	ER33	NA
Shock Amplifier	Endevco	2775A	EL81	NA
Item Accelerometer	Endevco	2228C	CW78	Dec 04
Data Acquisition	GHI Systems	CAT	Ver. 2.7.1	N/A

VIBRATION TEST EQUIPMENT - Test sequences 2 & 3.

EQUIPMENT	MANUFACTURER	MODEL	SN	CAL. DATE
Servohydraulic Vibration Machine	Team Corp.	Special	1988	N/A
Feedback Hardware Controller	Dactron Corp.	PCI DSP Card Front End DSP Box	2208515 4544828	Oct 04 N/A
Feedback Software Controller	Dactron Corp.	Version 2.1	N/A	N/A
Table Feedback Accelerometer	Endevco	2271AM20	10306	Dec 04
Feedback Amplifier	Endevco	2775A	EL65	N/A

APPENDIX 5: Distribution List

DISTRIBUTION LIST

DTIC/O
DEFENSE TECHNICAL INFORMATION CENTER
FORT BELVOIR VA 22060-6218

AFMC LSO/LO
WRIGHT-PATTERSON AFB OH 45433-5540

OC-ALC/GBMSTP
TINKER AFB OK 73145

OO-ALC/LGMPD
HILL AFB UT 84056-5805

WR-ALC/LGMTP
ROBINS AFB GA 31098-1670

OC-ALC/MNBDA
TINKER AFB OK 73145

AFMC 330 SOSG/LU
ROBINS AFB GA 31098-1670

APPENDIX 6: Report Documentation

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
29-03-2006

2. REPORT TYPE
Technical, Final Project Report

3. DATES COVERED *(From - To)*
May 05 - March 06

4. TITLE AND SUBTITLE
Development of the Combat Talon I - APQ-122 - Terrain Following Radar (TFR) Antenna Container, CNU-682/E, NSN 8145-01-535-3979

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

5d. PROJECT NUMBER
05-P-107

5e. TASK NUMBER

5f. WORK UNIT NUMBER

6. AUTHOR(S)
Matthew P. Bozzuto, Project Engineer
matthew.bozzuto@wpafb.af.mil, DSN 787-7166, Comm. (937)257-7166

Susan J. Evans, Qualification Test Engineer
susan.evans@wpafb.af.mil, DSN 787-7445, Comm. (937)257-7445

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
AFMC LSO/LOP
5215 THURLOW ST, STE 5, BLDG 70C
WRIGHT-PATTERSON AFB OH 45433-5540

8. PERFORMING ORGANIZATION REPORT NUMBER
06-R-02

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The Air Force Packaging Technology Engineering Facility (AFPTEF) was tasked with the design of a new shipping and storage container for the Combat Talon I - TFR Antenna in May of 2005. The new container is designed to replace the fiberglass container that was previously used.
The main problems with the fiberglass design were corrosion due to inadequate environmental control and protection, isolation system breakdown, and that there was no provision for effective warehouse stacking capability. AFPTEF solved these problems. The CNU-682/E, designed to SAE ARP1967A, is an aluminum, long-life, controlled breathing, reusable shipping and storage container. The new container, CNU-682/E, protects the TFR Antenna mechanically and environmentally. In addition, the new container makes the item much easier to maneuver during worldwide shipment and storage. The container passed all qualification tests per ASTM D4169.
The CNU-682/E container not only meets user requirements but also provides an economic saving for the Air Force. The savings will be thousands of dollars over the twenty-year life span of the container.

15. SUBJECT TERMS
CNU 682/E, Terrain Following Radar (TFR) Antenna Container, Aluminum Container, Reusable Container, Design, Test, Shock Vibration Isolator Mounted Item Container, Isolation System

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
U	U	U	UU	41	Matthew P. Bozzuto
					19b. TELEPHONE NUMBER *(Include area code)* (937)257-7166

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18